

July 23, 2002

MEMORANDUM FOR: David Minkel  
NGS Advisor for the State of Arizona

FROM: Charles W. Challstrom  
Director, National Geodetic Survey

SUBJECT: INSTRUCTIONS: ARIZONA FBN REPLACEMENT SURVEY, 2002  
(GPS-1713)  
Task Number: 8K6D2000 (FBN)

GENERAL:

The National Geodetic Survey (NGS), in accordance with NGS policy, will be coordinating the re-establishment of one Federal Base Network (FBN) station in the state of Arizona.

FBN station V 353 (PID DB0219) will soon be destroyed by road construction and will be replaced by X 7 (DB0227). Stations V 353, SENTINAL RESET (DA1175), RAMSEY (DV1145), JUNCTION (DB0369), YUMA NCMN (PID DB1233), YUM A (PID AC6848), WEST (PID DB0193), and FEDER RESET (PID DB1356) will be tied.

The coordinator is Mr. David Minkel, NGS State Advisor for Arizona. The project will be performed under the technical management of NGS.

PURPOSE:

In order to meet America's accelerating positioning and navigation needs, the existing coordinate reference system must be continually enhanced to provide the accessibility and high accuracy required for use with GPS. The digital revolution in mapping, charting, and surveying requires a National Spatial Reference System (NSRS) consisting of, among other components, a network of monumented points having four-dimensional positions. The FBN fulfills the requirements for this component. NGS is charged with the Federal responsibility for the establishment, observation, monitoring, and maintenance of the FBN. The FBN provides the critical network foundation for an accurate, consistent, reliable NSRS.

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The NSRS, in turn, provides the common geographic framework for America's spatial data infrastructure. As such, the NSRS serves as the basis for mapping, charting, navigation, boundary determination, property delineation, infrastructure development, resource evaluation surveys, and scientific applications, including crustal motion monitoring, modeling of flooding, storm surge, pollution trajectories, and agricultural runoff. A modernized, accurate, consistent, reliable NSRS is of enormous benefit to state, county, tribal, local, and Federal authorities, as well as to the private sector.

#### SPECIFICATIONS:

Project requirements for the FBN replacement observations are to ensure 2-centimeter local accuracy in the horizontal component, as well as 2-centimeter local accuracy for the ellipsoid heights.

Data from National CORS in the region are to be used in the processing. There are 11 National CORS in the area to choose from. Seven are in Arizona, two are in New Mexico, and one each is in California and Nevada.

The seven National CORS in Arizona are: Fredonia (FRED), Ferno Mesa (FERN), Flagstaff (FST1), Scottsdale (COSA), Tolleson (SRP1), Tucson (COT1), and Kingman (KING). The two in New Mexico are: Pie Town (PIE1) and Aztec (AZCN). The one National CORS in each of California and Nevada, respectively, is Blythe (BLYT) and Las Vegas (LVWD).

The position and data for these CORS are available from the NGS web site.

General specifications for the project are as follows. Two 5 ½ hour sessions are required with two 2-hour sessions to the close-by stations.

If possible, the start time of one of the long sessions should be 4 hours different from the other one.

In general, station occupation and observing procedures must be carried out according to appropriate sections of the "NGS Operations Handbook" and the current applicable receiver field manuals. Data formats and digital file definitions are given in "Input Formats and Specifications of the National Geodetic Survey Data Base," Volume I. Horizontal Control Data, Federal Geodetic Control Subcommittee, September 1994, revised and reprinted November 1998. Success in meeting the accuracy standards will be based on repeatability of measurements and adjustment residuals.

General specifications for the project are given in "Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques," Version 5.0: dated May 11, 1988, reprinted with corrections August 1, 1989. Specific project criteria and deviations from the general specifications are given in the following sections.

Project Network - A list (Table 1) and sketch of stations involved in this project will be provided.

Data Acquisition - Data collection must be accomplished as specified in the appropriate dual-frequency receiver field manuals in the compressed mode at a 15-second epoch collection interval. The GPS receivers must be dual-frequency and full-wavelength. Track satellites down to a 10-degree elevation angle.

Record weather data just before, immediately after, and at the mid-point of each session. Meteorological data shall also be collected immediately after an obvious weather front passes during a session and immediately before it passes, if possible. Pressure and relative humidity measurements must be made near and at about the height of the GPS antenna phase center. Indicate in the log the location of the barometer and psychrometer.

Survey operations shall be conducted with due regard to the safety of personnel and equipment. Contact with the airport traffic control tower is mandatory during surveys at any controlled airports.

Vector Computations - Data management, quality review of collected data, and final vector processing for the FBN replacement survey will be accomplished by Doug Hendrickson, N/NGS21, using PAGES. Vectors shall be computed in the International Earth Rotation Service Terrestrial Reference Frame (ITRF) system, using the most current epoch and precise IGS ephemerides. Use 30-second epoch intervals for data processing. The monument position will be used for the CORS if available, otherwise, the antenna reference point (ARP) position will be used.

The data will be processed in 24-hour sessions (or slightly longer if the observation session crosses 0000 UTC) in order to utilize the 24-hour data sets collected at the nearby CORS. The "fixed baseline" option in PAGES will be used to compute direct baselines between the CORS. The "fixed baseline" scheme will depend on the location and reliability of the CORS used in this project.

For stations where weather data are not available, or are suspect, predicted values computed in PAGES based on the station's latitude, height above mean sea level, and time and day of year will be used.

Use 15 degrees as the cutoff elevation angle in data processing. A cutoff angle of 10 degrees may be used when necessary to improve results.

The type of final solution, L1 versus ion-free, will depend on the length of the vectors. For vectors which are less than 10 km in length, the final reduction will consist of a L1 fixed solution. These vectors will be computed in a separate processing session from the longer vectors computed in an ion-free solution.

In general, vectors greater than 10 km in length are to be computed in an ion-free fixed, or partially-fixed, solution. In all cases, integer ambiguities will be fixed for each vector whenever possible.

The quality of collected data shall be determined from the plots generated from PAGES, by analysis of repeated vectors and/or comparison of station positions, and free adjustment residuals and/or loop misclosures. In addition, a constrained adjustment constraining the CORS will be performed.

Doug Hendrickson, N/NGS21, will perform all quality checks for conformance with NGS format standards such as executing software programs COMPGB, OBSCHK, and OBSDES. The final ITRF vectors will be assessed and transformed to the NAD 83 coordinate system using program ADJUST.

The data and results will be submitted to the Observation and Analysis Division. All B-files and G-files must be complete, including \*25\* and \*27\* records. Doug Hendrickson will be responsible for the B- and G-files; Dave Minkel will be responsible for the D-file.

Station Descriptions - Station recovery notes must be submitted in computer-readable form using WDDPROC software. Include the name, address, and, if public ownership, the telephone number of the responsible party. Do not include the telephone numbers of private property owners.

Special Requirements - Antenna set-up is critical to the success of this project. Fixed-height tripods are preferred for all receivers. The plumbing bubbles on the antenna pole of the fixed-height tripod must be shaded when plumbing is performed. They must be shaded for 3 minutes before checking and/or re-plumbing. Also, the perpendicularity of the poles must be checked at the beginning of the project and any other time there is suspicion of a problem.

When a fixed-height tripod is not used, the height of the antenna must be carefully measured to prevent station set-up blunders from occurring. Tribrachs used for these set-ups must be checked and adjusted when necessary. Totally independent measurements of the antenna height above the mark in both metric and English units must be made before and after each session. Someone other than the observer must check the measurement computations by carefully comparing measurements and then entering his/her initials on the log. Some GPS antennas have detachable ground planes and radomes. In order to help identify what exactly was used at a particular site, it would be useful to have a snapshot of the setup. All observers should take a photograph of the setup, if possible, with a close-up of the antenna as viewed from the side.

In addition, digital photographs of each survey mark are required. See "Requirements for Digital Photographs of Survey Marks & CORS Antennas," Version 5, for specific information.

In addition, a rubbing of the stamping of the mark must be made at each visit to a station. If it is impossible to make a rubbing of the mark, a plan sketch of the mark must be substituted, accurately recording all markings.

Also, for each station visited, a visibility obstruction diagram must be prepared and the TO-REACH description carefully checked for errors or omissions.

Lastly, the following must be recorded at each occupation of a station:

- (1) receiver manufacturer,
- (2) antenna manufacturer,
- (3) receiver model number (part number),
- (4) antenna model number (part number),
- (5) the complete serial number of the receiver, and
- (6) the complete serial number of the antenna.

Success of this project requires that the highest quality GPS data be collected. Therefore, during each station occupation, the operators shall carefully monitor the operation of the receivers. Any irregularities in the data due to equipment malfunction, DOD adjustment of the satellite orbit, obstructions, etc., must be reported to the Project Development Branch, N/NGS21, as soon as possible and noted on the observing log. If the quality of observations for an observing session is questionable, notify the Project Development Branch immediately.

The survey team shall not depart the project area until they have quality reviewed all data and advised N/NGS21.

GPS DATA:

Using TRIMBLE or other mission planning software, consult visibility tables and plots of the present satellite constellation to select the best observing windows.

Project report and data listed in Annex L of "Input Formats and Specifications of the NGS Data Base" must be transmitted. Any data considered suspect as to quality in achieving accuracy standards should be sent via FedEx immediately for office review. Backup of transmitted data must be held until notified by the Project Development Branch, N/NGS21.

The data set collected during the project shall be named "azre062d.984". All records in connection with this project shall be titled "ARIZONA FBN REPLACEMENT SURVEY, 2002". The project number (accession number) is GPS-1713.

LIAISON:

Liaison must be maintained with designated offices at the National Geodetic Survey headquarters located at:

1315 East-West Highway  
Silver Spring, Maryland 20910-3282

Questions and problems concerning adjustment processing should be directed to:

Maralyn L. Vorhauer  
Observation and Analysis Division  
N/NGS4, SSMC III, Station 8562  
Telephone: 301-713-3176, ext. 104  
Fax: 301-713-4327  
e-Mail: Maralyn.Vorhauer@noaa.gov

Questions and problems concerning vector processing should be directed to:

Juliana Blackwell  
Field Operations Branch  
Observation and Analysis Division  
N/NGS41, SSMC III, Station 8458

Telephone: 301-713-3215, ext. 108  
Fax: 301-713-4327  
e-Mail: Juliana.Blackwell@noaa.gov

Questions and problems concerning using CORS data in processing should be directed to:

Neil Weston  
Geosciences Research Division  
N/NGS6, SSMC III, Station 9830  
Telephone: 301-713-2847, ext. 202  
Fax: 301-713-4475  
e-Mail: Neil.Weston@noaa.gov

Questions and problems which could affect the technical adequacy of the project should be directed to:

Stephen J. Frakes (Douglas R. Hendrickson)  
Chief, Project Development Branch  
Spatial Reference System Division  
N/NGS21, SSMC III, Station 8853  
Telephone: 301-713-3194, ext. 111 (ext. 127)  
Fax: 301-713-4316  
e-Mail: Steve.Frakes@noaa.gov or  
Doug.Hendrickson@noaa.gov

The coordinator for the observations is the Arizona State Advisor:

David Minkel  
Office of the State Cartographer  
1616 West Adams Street  
Phoenix, Arizona 85007  
Telephone: 602-542-1569  
Fax: 602-542-2600  
e-Mail: Dave.Minkel@noaa.gov

Names and telephone numbers of local contacts are given in the station description material.

ADDRESS:

Keep N/NGS21 informed of the party's physical address and telephone number at all times.

PUBLICITY:

See "NGS Operations Handbook," Section 1.4.1.

EXPENSES:

Expenses for this project will be charged to task number 8K6D2000.

TRAVEL:

Travel and per diem are authorized in accordance with Federal Travel Regulations, Part 301-11, Per Diem Allowances. Current per diem rates were effective October 1, 2001.

ACKNOWLEDGMENT:

Please acknowledge receipt of these instructions in your Monthly Report.

cc: N/NGS - D. Zilkoski\*  
N/NGS - S. Misenheimer\*  
N/NGS1 - G. Mitchell  
N/NGS1x1 - D. Minkel  
N/NGS11 - S. Cofer  
N/NGS21 - S. Frakes  
N/NGS21 - R. Anderson  
N/NGS21 - D. Hendrickson\*  
N/NGS22 - T. Soler  
N/NGS3 - J. Bailey  
N/NGS4 - E. Wade  
N/NGS4 - M. Vorhauer  
N/NGS4 - D. Hoar  
N/NGS41 - W. McLemore  
N/NGS41 - J. Blackwell  
N/NGS5 - R. Snay  
N/NGS6 - N. Weston  
FGCS Members\*

\* first page only